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## (54) IMPROVEMENTS IN OR RELATING TO STRUCTURAL JOINTS

(71) We, MASSEY-FERGUSON-PERKINS SERVICES NV., formerly, Massey-Ferguson Services NV., Abraham de Veerstraat 7a, Curacao, Netherlands Antilles, a company organised under the laws of the Netherlands Antilles, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention concerns a frame construction and has particular utility for roll-over protection structures for mobile working and construction machines, agricultural tractors, fork-lifts and so on.

In the case of such vehicles it is a legal necessity to protect the driver from injury if the vehicle capsizes. For this reason the drivers station on such machines is protected by a roll-over protection structure which may form part of a capsize safe drivers cab.

Usually hollow sections are used for the roll-over protection structure, these sections being welded together at the points of connection and still further reinforced by additional structural elements. Nevertheless it has been shown that the frame work of most protective structures does not fulfil the necessary requirements. Because of fatigue due to constant vibration and violent impacts, welding cracks appear at the intersection, the result being that when there is a real capsize the protective structure is deformed and crushed.

It is an object of this invention to make a frame suitable for use as a roll-over protective structure which is less susceptible to welding fatigue.

According to the present invention there is provided a framework including two joined frame members both of tubular form, one end of each frame member being slit generally longitudinally and opened up to provide two or more partial sections, and at least two of the partial sections at said one end of one of the frame members being secured to partial sections formed at said one end of the other frame member.

The invention also provides a roll-over

protective structure for a vehicle including a plurality of corner posts, and separately formed roof members extending between the upper ends of the corner posts, said corner posts and roof members being of tubular form with the upper end of each corner post and each end of each roof member being slit generally longitudinally and opened up to provide two or more partial sections, and at least two of the partial sections at each end of each roof member being secured to partial sections formed at the upper end of the corner post to which the roof member is connected.

The invention further provides a method of forming a joint between two tubular members and a method of forming a roll-over protective structure.

Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a roll-over protective structure for use on an earth-working machine;

Figure 2 is an enlarged view of the joint between a pair of perpendicular members as circled and labelled II in Figure 1;

Figure 3 is a view on the line III-III of Figure 2;

Figure 4 is an enlarged view of the joint shown within the circle IV in Figure 1;

Figure 5 is an enlarged view of the joint indicated by the arrow V in Figure 1;

Figure 6 is an enlarged view of the joint shown within the circle VI in Figure 1;

Figure 7 is an enlarged view of the joint shown within circle VII in Figure 1;

Figure 8 is an exploded view of the components of the joint shown within circle VIII in Figure 1;

Figure 9 is an exploded view showing the components of the joint of Figure 8 partly assembled;

Figure 10 is a view of the assembled joint shown in Figure 8;

Figure 11 is a view in the direction of arrow XI in Figure 8;

Figure 12 is an exploded view showing the

components of an alternative form of joint to that shown in Figure 8;

Figure 13 is a rear view of the joint shown in Figure 12 partly assembled;

5 Figure 14 is a view of the joint of Figure 12 assembled.

Referring now to Figure 1 a roll-over protective structure S for an earthworking machine T comprises four corner posts 1—4  
10 mounted on a platform 5 and interconnected by transverse roof members 7 and 9 and longitudinal roof members 6 and 8 respectively. Uprights 10, 11 respectively extend between the platform 5 and the longitudinal  
15 roof members 6, 8 to define doorways in the structure 1.

A horizontal longitudinal member 12 is connected between one of the uprights 11 and the corner post 3 and a horizontal transverse  
20 member 13 is connected between the corner posts 1 and 4 to define a windscreen aperture. The structure S is completed by uprights 14 each extending between a transverse member  
25 15 attached to the front of the platform 5 and the member 13 adjacent the engine cover 16.

A cruciform of braces 17, 18, 19, 20 connected to the roof members 6—9 respectively are provided in the roof of the structure 1.

The structural members 1—4, 6—15, and  
30 17—20 are conveniently fabricated from square section thick walled tubing though the invention may be applied to any form of convenient tubular structural material.

The method of manufacture of the joint  
35 between the member 15 and the upright member 14 is best understood by reference to Figures 2 and 3.

The upright 14 is split along its longitudinal axis to form channel sections 14 a, 14 b respectively. The split terminates at a hole 21 passing through the upright 14. A pair of channel sections 15a, 15b are similarly formed at the end of the transverse member 15 terminating at a hole 22. The inner sections 14 b, 15 b are then bent inwardly to the desired orientation, as determined by the relative lengths of the channel sections, and cut to length so as to form a butt joint. The extremities of the channel sections 14 a, 15a are mitred at 45 degrees and the two members 14, 15 joined by welding  
50 along the mitred edge between the sections 14a, 15a and along the butt joint between the sections 14b, 15b.

Fillet plates 23, 24 are welded on opposite  
55 sides of the members 14, 15 to complete the joint.

Figure 4 shows the construction of the joint between the uprights 10 and the roof member 6 which is formed from two parts 6a, 6b. Each of the roof members 6a, 6b is slit along its longitudinal axis and one leg of each bent and cut to length as described above with reference to Figure 1.

The upright 10 is also slit along its longitudinal axis and each leg so formed bent  
65 away from the axis to form a Y. The unbent legs of the roof members 6a, 6b may then be butt welded together and the bent legs welded to the appropriate leg of the upright 10. A triangular fillet plate 26 may then be welded over the joint. If desired through bores 27, 28, 29 may be provided in the roof members 6a, 6b and the upright 10 respectively to terminate the slit portion.

Figure 5 shows the joint between the roof  
75 braces 17, 18, 19, 20. Each of the braces 17—20 are slit and bent to form a Y with a 90 degree included angle in the manner described above with reference to the upright 10 in Figure 4. The braces may then be welded together to define a rhombic aperture and a plate 30 welded to the braces to cover the aperture.

The embodiments of Figures 6 and 7 show joint 5, formed between two tubes 13 and 14, 11 and 5, respectively, in which only one tube 14 in each case is split along its longitudinal axis. The legs may be bent to the form shown in either Figure 2 or Figure 4 and butt welded to the other tube. A plate 31 is then welded on either side of the split tube to cover the aperture.  
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The above embodiments show arrangement for forming joints between structural members which lie in the same plane. The embodiments of Figures 8 to 14 show joint 5 formed between members lying in mutually perpendicular planes.  
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In Figures 8, 9, 10 and 11 the joint is formed between three mutually perpendicular members 1, 6a and 9 so as not to encroach on the space within the joint.  
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The members 9 and 6a are split along their longitudinal axis and one of the legs so formed bent away from the axis in the manner described above with reference to Figure 2. The ends of the unbent legs are mitred at 45 degrees. The walls of the upright 1 are slit along the axes A, B and C as shown in Figure 11.  
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The legs between the axes A and C and C and B are bent to the positions indicated in chain dotted lines in Figure 11. The leg formed between the axes A and B is left unbent. The two bent legs are cut to length and butt welded to the respective bent legs of the members 9 and 6a. The mitred ends of the members 9 and 6a are welded to one another and to the unbent leg of the upright 1. The apertures between the legs are then covered by plates 32, 33, 34, 35.  
110 115 120

The embodiments of Figures 12 to 14 show an alternative structure, not shown in Figure 1, which includes a diagonal brace in all three planes. Each of the members 6b, 7 and 2 are slit and bent in the manner described above with reference to Figure 11. The ends are cut to length and mitred as required to enable them to be welded to the form shown in Figure 13.  
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The apertures so formed may be covered by  
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plates 36, 37, 38 and 39 to form an enclosed joint.

# WHAT WE CLAIM IS:—

1. A framework including two joined frame members both of tubular form, one end of each frame member being slit generally longitudinally and opened up to provide two or more partial sections, and at least two of the partial sections at said one end of one of the frame members being secured to partial sections formed at said one end of the other frame member.

2. A roll over protective structure for a vehicle including a plurality of corner posts, and separately formed roof members extending between the upper ends of the corner posts said corner posts and roof members being of tubular form with the upper end of each corner post and each end of each roof member being slit generally longitudinally and opened up to provide two or more partial sections, and at least two of the partial sections at each end of each roof member being secured to partial sections formed at the upper end of the corner post to which the roof member is connected.

3. A roll over protective structure according to claim 2 in which the upper end of each corner post is slit to provide three partial sections, one of said corner post partial sections extending generally parallel to the longitudinal axis of said corner post and the other two corner post partial sections being bent away from said axis, said one corner post partial section being secured to one partial section of each roof member connected to said corner post and the other two partial sections of the corner post being respectively secured to a further partial section of a respective one of the roof members connected to said corner post.

4. A roll over protective structure according to claim 3 in which the ends of the roof members are split to provide two partial sections, a first partial section which is secured to said one corner post partial section and a second partial section which is secured to one of said other two corner post partial sections.

5. A roll over protective structure according to claim 3 in which the ends of the roof members are split to provide three partial sections, a first partial section which is secured to said one corner post partial section, a second partial section which is secured to one of said other two corner post partial sections, and a third partial section which is secured to the corresponding third partial section of the other roof member connected to said corner post.

6. A roll over protection structure according to claim 4 or claim 5 in which said first partial section at each end of each roof member is unbent and mitred, said first partial sections associated with each corner post

being secured to each other as well as said one corner post partial section.

7. A roll over protection structure according to any one of claims 2 to 6 in which base members extend between the lower ends of the corner posts, said base members being secured to said corner posts in the same manner as said roof members.

8. A roll over protective structure according to any one of claims 2 to 7 in which one or more additional tubular members are secured to the roof members or base members, the ends of each said additional frame member being slit generally longitudinally and opened up to provide partial sections and said partial sections being secured to the roof members or base members in question.

9. A roll over protection structure according to claim 8 in which the roof member or base member to which an end of an additional frame member is secured is formed in two parts arranged to be jointed at the location of the joint with the additional frame member, the ends of the parts at the location of said joint being slit generally longitudinally and opened up to provide two partial sections, one partial section of each part being secured to one partial section of the other part and the other partial section of each part being secured to a respective one of the partial sections of the additional frame member.

10. A roll over protection structure according to any one of claims 2 to 9 including a roof section secured between the roof members, said roof section comprising four tubular brace members secured together in the form of a cross by slitting and opening up one end of each brace member to form two partial sections and joining the right partial section of one brace member to the left partial section of one adjacent brace member and the left partial section of said one brace member to the right partial section of the other adjacent brace member.

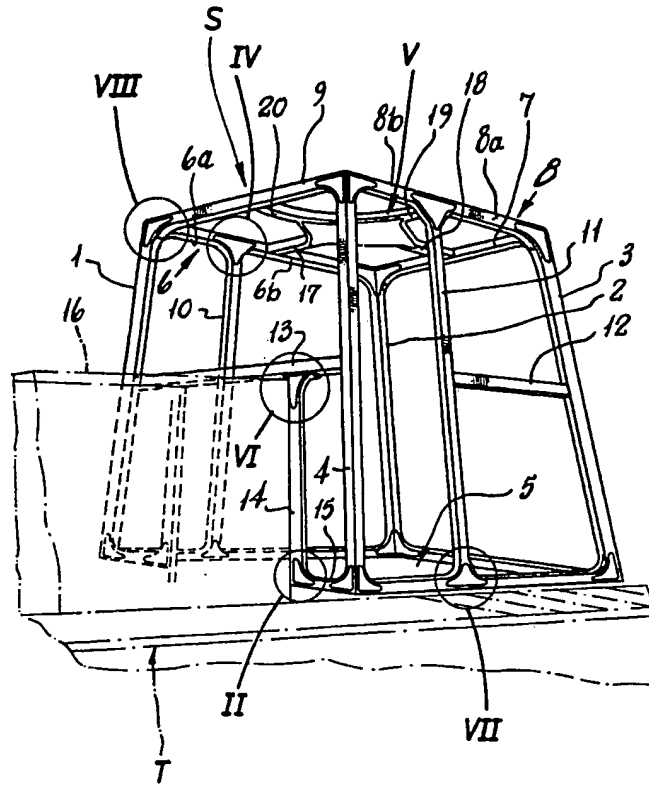
11. A roll over protective structure according to any one of claims 2 to 10 in which each joint formed by slitting is reinforced by a plate extending between and secured to the partial sections of the joint.

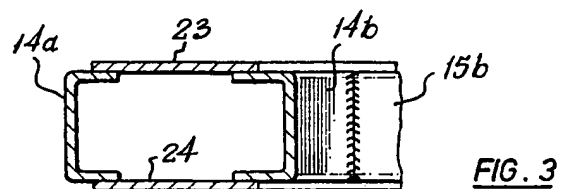
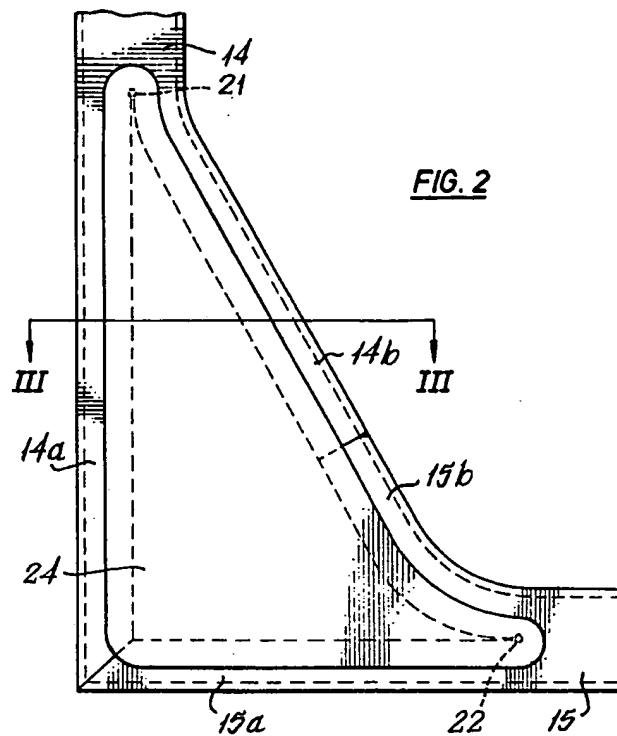
12. A roll over protective structure according to any one of claims 2 to 11 in which the partial sections, and reinforcing plate if present, are secured together by welding.

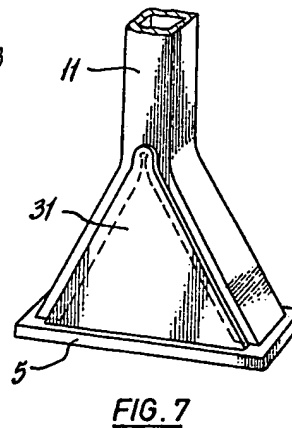
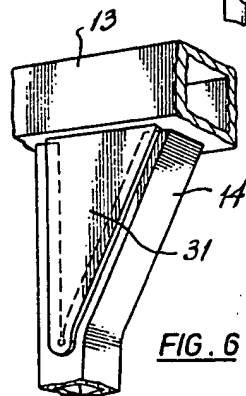
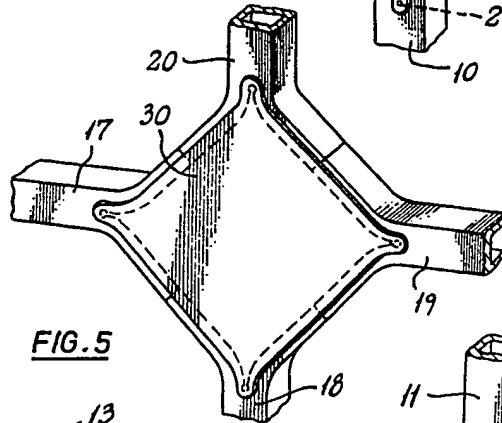
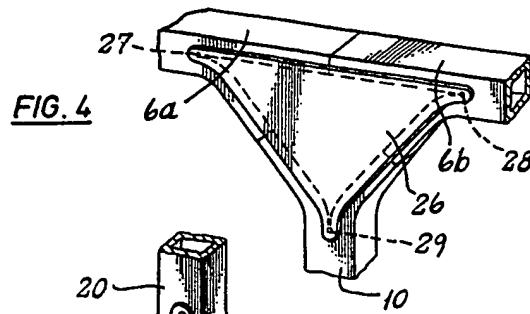
13. A method of forming a joint between the ends of two tubular frame members, said method comprising forming generally longitudinally extending slits in said ends of said members, opening up said slits to provide two or more partial sections, and securing at least two of the partial sections formed at the end of one frame member to partial sections formed at the end of the other frame member.

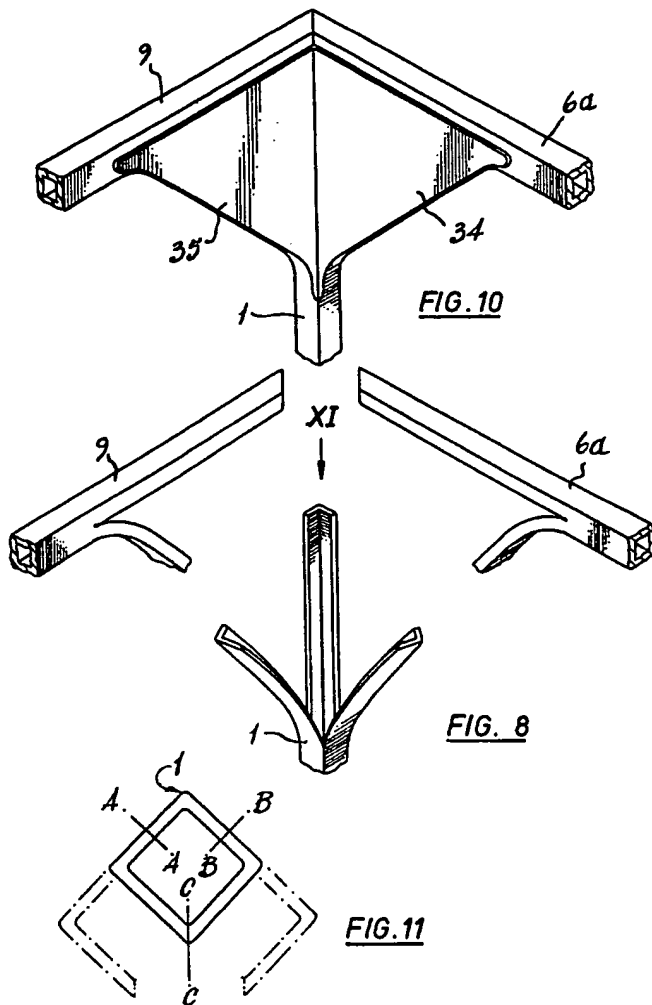
14. A method according to claim 13 including the further step of securing a rein-

- forcing plate between said partial sections of the joint.
15. A method of forming a roll over protective structure for a vehicle including a plurality of tubular corner posts and separately formed tubular roof members extending between the upper ends of the corner posts, said method comprising generally longitudinally slitting the upper end of each corner post and each end of each roof member, opening up these slits to form two or more partial sections at each slit member end, and securing at least two of the partial sections at each end of each roof member to partial sections formed at the upper end of the corner post to which the roof member is to be connected.
16. A roll protective structure for a vehicle constructed and arranged substantially as hereinbefore described with reference to and as shown in Figure 1 of the accompanying drawings.
17. A framework including a joint constructed and arranged substantially as hereinbefore described with reference to and as shown in Figures 2 and 3 of the accompanying drawings.
18. A framework including a joint constructed and arranged substantially as hereinbefore described with reference to and as shown in Figure 4 of the accompanying drawings.
19. A framework including a joint constructed and arranged substantially as hereinbefore described with reference to and as shown in Figure 5 of the accompanying drawings.
22. A framework including a joint constructed and arranged substantially as hereinbefore described with reference to and as shown in Figures 8 to 11 of the accompanying drawings.
23. A framework including a joint constructed and arranged substantially as hereinbefore described with reference to and as shown in Figures 12 to 14 of the accompanying drawings.
- D. BRYN JONES,  
Chartered Patent Agent,  
Agent for the Applicants.











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COMPLETE SPECIFICATION

7 SHEETS

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Sheet 5

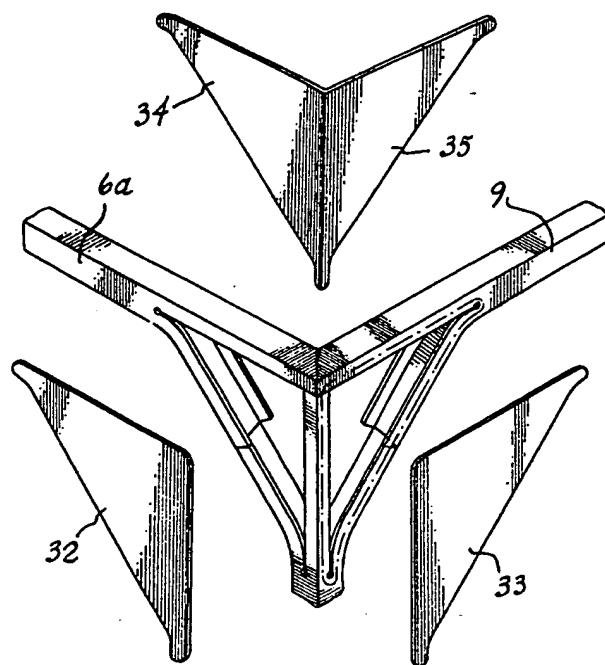


FIG. 9

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Sheet 6*

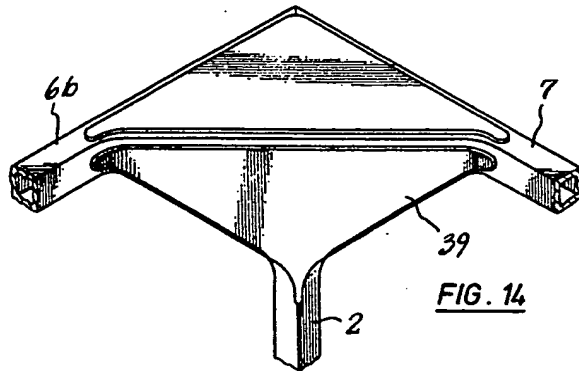


FIG. 14

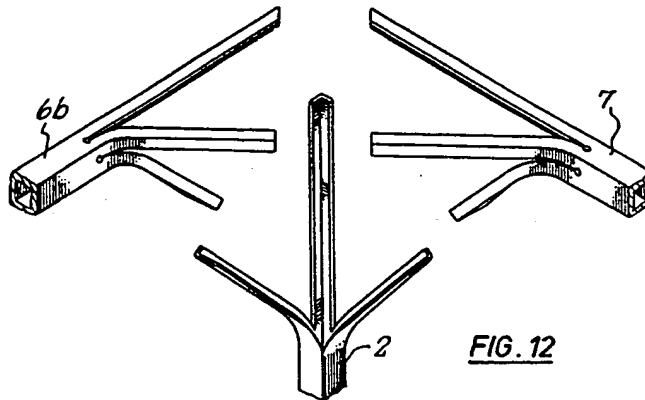


FIG. 12

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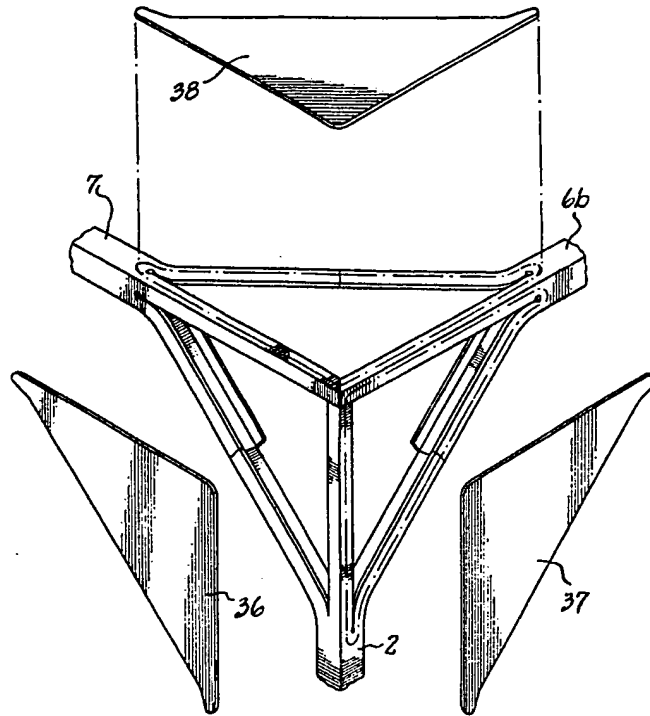


FIG. 13